a statistical tolerance analysis package E3 communicating with said tolerance allocation module M6 for providing an algebraic visualization of tolerancing of said object.--

REMARKS

Request for Information

In paragraph numbers 17-28 of the Office Action, the Examiner requested copies of certain publications because they appear to the Examiner as germane to the claimed invention. Applicant hereby provides relevant pages of references available to the Applicant, while other references are not available to Applicant, as follows:

(1) "ANSI/ASME Y14.5 1994 standard on tolerances" referenced at page 9 of the specification. This document is copyrighted and only available from ASME (American Society of Mechanical Engineers, New York) for a fee of $100.

(2) "Introduction to Geometry" at specification page 19. Relevant pages enclosed.

(3) "Instantaneous Properties of Multi-degrees of Freedom Motions-Line Trajectories" at specification page 24. Reference to this document has been deleted from the specification.

(4) "Analytic Geometry of Three Dimensions" at specification page 25. Relevant pages are enclosed.

(5) “On a new geometry of space” at specification page 26. Relevant pages are enclosed.

(6) “Kinematic geometry of mechanisms” at specification page 26. Relevant pages are enclosed.

(7) “The Theory of Screws” at specification page 28. Reference to this document has been deleted from the specification.

(8) “HA Computational Model for Geometric Dimensions and Tolerances Consistent with Engineering Practices” at specification page 30. Applicant is obtaining this document to provide to the Examiner.

(9) “Representation and mapping of geometric dimensions from design to manufacturing” at specification page 30. Applicant is obtaining this document to provide to the Examiner.

(10) Copies of a user manual for each of three engines: one commercial geometry engine, one commercial constraint solver, and one commercial tolerance analysis package, as discussed at specification page 18. Relevant pages of overview for DCM and ACIS, and a review article about VSA (a commercial tool analysis package) are enclosed.

Claim Interpretation

In paragraph 30 of the Office Action the Examiner states that Claim 1 specifies “tolerance map”, which is interpreted as “a convex volume whose shape depends on the tolerance type and whose size depends on the tolerance values”

at specification page 10 line 8, or "finite set of multivariate regional models" at specification page 17 line 9. It is respectfully submitted that the two descriptions the Examiner identifies on pp. 10 and 17 are consistent. The term "multivariate regional models" can also be regarded as "multidimensional point-spaces", and both can be described as multidimensional solids.

In paragraph 31 of the Office Action the Examiner states that Claim 20 specifies "geometry engine system M1", which is inconsistent with FIG. 13 element "M1 Geometry Definition System", and is inconsistent with page 45 line 1 "module M1 for geometry definition". The Examiner interprets the Claim 20 modules as equivalent to the FIG. 13 modules. The Examiner suggests that the specification, or figures, or claims should be amended to yield consistent module terminology. This is now moot because claim 20 has been rewritten as new 24.

Claim Rejections

Claims 1-20 are pending in the above-referenced patent application. Claims 1-5, 7-8, 16-17 and 19 were rejected under 35 U.S.C. 102(b) as being anticipated by U.S.P.N. 5,586,052 to Iannuzzi et al ("Iannuzzi").

Claims 6 was rejected under 35 U.S.C. 103(a) as being unpatentable over Iannuzzi in view of U.S.P.N. 6,137,492 to Hope. Claim 9 was rejected under 35 U.S.C. 103(a) as being unpatentable over Iannuzzi in view of U.S.P.N. 6,256,091

to Krishnamurthy. Claim 10 and 11 were rejected under 35 U.S.C. 103(a) as being unpatentable over Iannuzzi in view of U.S.P.N. 4,800,652 to Ballas, *et al* ("Ballas"). Claim 12 was rejected under 35 U.S.C. 103(a) as being unpatentable over Iannuzzi in view of U.S.P.N. 5,875,264 to Carlstrom. Claim 13 was rejected under 35 U.S.C. 103(a) as being unpatentable over Iannuzzi in view of U.S.P.N. 5,574,468 to Rose. Claim 14 was rejected under 35 U.S.C. 103 (a) as being unpatentable over Iannuzzi in view of U.S.P.N. 4,649,498 to Kedem et al ("Kedem"). Claim 15 was rejected under 35 U.S.C. 103 (a) as being unpatentable over Iannuzzi in view of U.S.P.N. 5,549,857 to Kamiguchi. Claim 18 was rejected under 35 U.S.C. 103 (a) as being unpatentable over Iannuzzi. Claim 20 was rejected under 35 U.S.C. 103 (a) as being unpatentable over Applicant's Admission (commercial software) in view of Maxey (AutoCAD).

Claims 13, 14, 15 and 20 have been canceled. New claims 21-24, have been added. Claims 2, 3, 4, 5, 8, 9 and 11 have been amended. No new matter has been added.

Claim rejections under 35 U.S.C. 102(b)

The rejection of claims 1-5, 7-8, 16-17 and 19 is respectfully traversed because Iannuzzi does not disclose all of the limitations of the claims.

Iannuzzi is directed to a method of storing and organizing pieces of information relevant to GD&T (Geometric Dimensioning and Tolerancing). Using

Table Lookup and Rules Iannuzzi provides a procedure to validate only certain aspects of completeness and correctness (col. 4, lines 18-27; col. 8, lines 42-46). By contrast, according to the claimed invention herein, there are two distinct models/levels for evaluating tolerances of computer assisted designs: a local level and a global level. The local model is quantitative because it considers the size and shape of tolerance zones resulting from stackup or accumulation of variations. The global model is qualitative because it validates the relationships between toleranced features, tolerances, DRF, relationships between tolerances on the same features and between all DRFs in a model.

For example, unlike the local model in the present invention, Iannuzzi does not disclose accumulation of tolerances in stackup, i.e. there is no method provided on how tolerances in a dimension loop accumulate. Iannuzzi does not consider tolerance zones at all (neither the shape nor size). Iannuzzi does not disclose any quantitative analysis of the effect of different tolerances on the size, shape and juxtaposition of tolerance zones resulting from several tolerances applied to the same feature. And, Iannuzzi has absolutely no overlap with either the application or the techniques used for our creating local models according to the present invention.

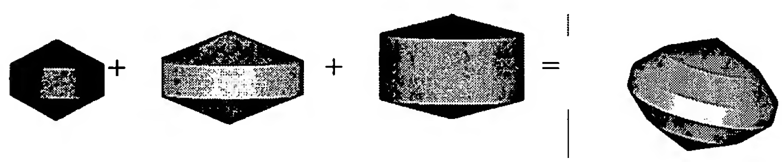
As per Claim 1, in the Office Action, the Examiner states that the claimed limitation of "representing each tolerance zone for each geometric feature of said object by a model with an algebraic form and a geometric form as a tolerance

map" (claim 1) is disclosed by Iannuzzi at abstract "input of geometric data representing features of a manufactured part and data representing datums and tolerances for features". Applicant respectfully traverses this interpretation of Iannuzzi. The passage in Iannuzzi seems to refer to the input to a program. The input to a program according to the method of the present invention, as well as Iannuzzi, is the same – i.e. the geometric data, dimensions, tolerances, datums. The input only specifies the part or assembly definition. Rather, the present invention provides a computational process and type of output that is patentably distinct from Iannuzzi.

Further, the Examiner states that "computing...interdependencies between said stored maps and interdependencies between submaps of said stored maps to determine how different tolerance zones for said geometric feature affect each other and to determine how different tolerance zones for different geometric features of said object affect each other" (claim 1) is disclosed by Iannuzzi at abstract "Relationships are established between the data and degrees of freedom are determined for the part features and tolerances". Applicant respectfully traverses this interpretation of Iannuzzi. Iannuzzi does not utilize tolerance zones or maps. Neither is Iannuzzi concerned with how errors due to imperfections accumulate. Iannuzzi only verifies the type of tolerance and datums. Iannuzzi does nothing with the amount of the tolerance, and does not combine this amount with other amounts. Degree of freedom is quite distinct from tolerance value. Iannuzzi simply stores the values wherein all the analysis is

based on DoFs not tolerance values (e.g., zone sizes or shapes) as claimed herein.

To help understanding, the example figure below shows how accumulation of tolerances is computed according to the claimed invention, wherein individual tolerance maps (T-Maps) are generated first, followed by Minkowski addition.

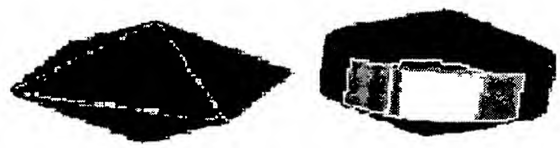


There is no teaching in Iannuzzi that is in any way similar.

The Examiner further states that "selecting tolerance conditions for said object to optimize allocation of tolerances to each of said geometric features of said object" (Claim 1) is disclosed by Iannuzzi at abstract "determine if the tolerance plan defined by a designer is complete and well formed. If it is not, the designer may then revise the tolerance plan to provide for a more consistent and useful tolerancing plan resulting in higher quality, lower cost manufactured parts and assemblies". Applicant respectfully traverses this interpretation of Iannuzzi because Iannuzzi does not disclose the claimed optimization step. Indeed, "complete and well formed" as required by Iannuzzi, does not teach or suggest "optimal" as required by Claim 1. To be optimal, a design must meet more than just the minimum requirements (complete and well formed), and essentially be

the best possible. Therefore, for at least the above reasons, it is respectfully submitted that Claim 1, and all claims dependent therefrom, should be allowed.

As per Claim 2, the Examiner states that the limitation of a "tolerance map representing a plane", is disclosed by Iannuzzi (col. 5, line 13 "plane"). Applicant respectfully traverses this interpretation of Iannuzzi. Further, Claim 2 has been amended for clarification. Further, a tolerance map (T-Map) is a procedure is a novel feature disclosed by the present invention, and not disclosed by the references. In one example, generating a tolerance map according to the present invention, involves making special choices in locating the vertices of simplexes when building hypothetical point-spaces in 3D, 4D, 5D, or higher dimension. Through a mapping procedure, the manufacturing imperfections of a feature in real 3D space are represented in the hypothetical space. In 3D space, the imperfections of each feature are represented with zones in the national standard (ASME Y14.5). Every allowable manufacturing variation in a zone is mapped to another equivalent element (e.g., a single point, or a sub-volume) in the hypothetical space. The collection of the mapped entities forms the T-Map and its subsets according to the present invention. For example, planes map to points in 3D hypothetical space, giving volumes, such as shown by the example figure below (the figure on the left is for size variations of a rectangular bar and the figure on the right is for a round bar with both size and orientational tolerances applied.)



By contrast, Iannuzzi represents planes with planes, and nodes in their data structure is labeled as such. This can be clearly seen in Iannuzzi's Fig. 9 with F1 node. There is no mapping to T-Maps or any other type of multi-variate region in hypothetical space, as claimed herein. Therefore, for at least the above reasons, Claim 2 should be allowed.

As per Claim 3, the Examiner states that "tolerance map representing a axis or edge" is disclosed by Iannuzzi (col.5 , line 13, "cylindrical or spherical surface", where cylinders are represented by an axis, a diameter, and a height). Applicant respectfully traverses this interpretation of Iannuzzi. Further, Claim 3 has been amended for clarification. According to the claimed invention, a T-Map for an axis (or edge) is a 4D hypothetical space that represents the entire array of manufacturing imperfections for that axis (edge). Such a T-Map is a higher-dimension 4D solid (hypervolume). Each imperfect axis, with its location and orientation, is represented by a point in the 4D hypothetical space. Imperfections in form, such as straightness, are represented as a sub-volume (sub-set) within the T-Map. By contrast, Iannuzzi uses an axis as one element for representing a cylinder, and nowhere does Iannuzzi disclose a way to embody all variational possibilities of manufacture for it in a volume of some sort as claimed. Therefore, for at least the above reasons Claim 3 should be allowed.

As per Claim 4, the Examiner states that "cylindrical surface" is disclosed by Iannuzzi (col. 5, line 13, "cylindrical or spherical surface"). Applicant respectfully traverses this interpretation of Iannuzzi. Further, Claim 4 has been amended for clarification. According to the claimed invention, a T-Map for a cylinder is a 5D hypothetical space that represents the entire array of manufacturing imperfections for that cylinder. Such a T-Map is a higher-dimension 5D solid (hypervolume). Each imperfect cylinder, with its location, orientation, and size, is represented by a point in the 5D hypothetical space. Imperfections in form, such as straightness, or out-of-roundness, are represented as a sub-volume (sub-set) within the T-Map. By contrast, Iannuzzi represents cylinders by an axis, a diameter, and a height, and nowhere does Iannuzzi disclose a way to embody all variational possibilities of manufacture for the cylinder in a volume of some sort as claimed. Therefore, for at least the above reasons Claim 4 should be allowed.

As per Claim 5, the Examiner states that "position" is disclosed by Iannuzzi (col. 5, line 26, "datum"). Applicant respectfully traverses this interpretation of Iannuzzi. The term "position" is used widely in the national standard (ASME Y14.5), both related to the position of toleranced features and to the position of datums. However, the position of a datum relative to a toleranced feature can influence the shape of a T-Map, but only when the rules and procedures of the ASME Standard dictate such an influence. By contrast,

Iannuzzi uses the term “position” in relation to datums in the same context as the national standard, but nowhere does Iannuzzi disclose use of position to influence the shape of a higher-dimensional point-space for representing manufacturing variations as claimed. Therefore, for at least the above reasons Claim 5 should be allowed.

As per Claim 7, the Examiner states that “variational possibilities of features” is disclosed by Iannuzzi at abstract “revise the tolerancing plan”. Applicant respectfully traverses this interpretation of Iannuzzi. An objective of a CAT system according to the present invention is to help a designer optimize tolerances so that variational possibilities of manufactured features are kept within allowable limits that are specified by tolerances. By contrast, in Iannuzzi, revisions of the tolerance plan are left up to the designer, the system only being able to analyze the resulting changes that are input to it. Therefore, for at least the above reasons Claim 5 should be allowed.

As per Claim 8, the claim has been amended for clarification. The Examiner stated the same reasons as in rejection of Claim 7 to reject Claim 8. It is respectfully submitted that for at least the reasons provided in regards to Claim 7, the rejection of Claim 8 should be withdrawn.

As per Claim 16, the Examiner states that “validated using degree of freedom” is disclosed by Iannuzzi at abstract “degrees of freedom”. Applicant

respectfully traverses this interpretation of Iannuzzi. As noted, the global model according to the present invention provides the degree of freedom analysis. The intended application of the Iannuzzi model and the global model according to the present invention can be similar (i.e., validation of corrections and completeness of tolerance specification). However, the technique/methods by which these objectives in Iannuzzi and the claimed invention are achieved are patentably distinct.

These differences account for different capabilities of the two systems. In Iannuzzi, the Network Tester (Fig. 3, #30) uses a Rule Set (#32) (col. 14, lines 3-7). By contrast, according to the claimed invention, rather than Rules, mathematical relations which are solved by an external constraint solver are used (e.g., specification, Fig. 13, E2). Rules are not mathematically tractable and are prone to errors. Rules cannot solve strongly corrected components in constraint networks, which have coupled constraint requiring simultaneous solving.

Further, in validating if the proper DOFs of a feature are controlled by a DRF, Iannuzzi compares the composite DOFs of the DRF to the controllable DOFs of the toleranced feature (Iannuzzi, Fig. 7, #146). Because the total DOFs of the DRF are considered at the collective level, Iannuzzi is unable to determine which DOFs are controlled by each of the composing datums of the DRF. Iannuzzi, Table II, does not shows any association between each datum and the

particular DOFs controlled when combined with other datum. For example, Table II, line 2, shows that when a point is used as a primary datum, another point as a secondary datum, DOFs u, v are controlled, but does not indicate which datum controls u and which datum controls v (no distinction is made).

By contrast, the global model according to the present invention analyzes the DOFs controlled progressively, that allows determining not only what DOFs are controlled collectively by all datums in the DRF, but also which individual datum controls each DOF. Without this distinction, the effect of datum precedence cannot be analyzed.

And, Iannuzzi does not provide any mechanism for controlling the same DOF by more than one DOF. This is needed when finer controls are required on certain DOFs selectively. This is referred to as tolerance refinement. An orientation tolerance refines a size tolerance; a form tolerance refines an orientation tolerance. Iannuzzi discloses nothing about such redundant controls and conditions under which they are permissible. By contrast, the global model according to the present invention accounts for these refinement relations under redundant controls. Therefore, it is respectfully submitted that for at least the above reasons Claim 16 should be allowed.

As per Claim 17, the Examiner states that "forming datum reference frames as rigid sets for target features and feature patterns" is disclosed by

Iannuzzi (FIG. 3, element 26, "Datum Reference Frame List"). Applicant respectfully traverses this interpretation of Iannuzzi for the same reasons at provided above in regards to Claim 16. Therefore, it is respectfully submitted that for at least the above reasons Claim 17 should be allowed.

As per Claim 19, the Examiner states that "identifying redundant or conflicting restraints by using a degree of freedom" is disclosed by Iannuzzi at abstract "degrees of freedom". Applicant respectfully traverses this interpretation of Iannuzzi for the same reasons at provided above in regards to Claim 16. Therefore, it is respectfully submitted that for at least the above reasons Claim 19 should be allowed.

Claim rejections under 35 U.S.C. 103(a)

The rejection of claims 6, 9-12, 18 and 20 under 35 U.S.C. 103(a) is respectfully traversed because, as discussed below, the claims include limitations not taught or suggested by the references, alone, or in combination.

Claim 6 was rejected under 35 U.S.C. 103(a) as being unpatentable over Iannuzzi in view of Hoppe. The Examiner states that Iannuzzi does not disclose "composite tolerances constructed as Minkowski sum" (Claim 6), but that Hoppe at col. 19, lines 2-15 discloses "space error exceeds a pre-determined tolerance... Hausdorff distance and Minkowski sum are known to those skilled in the art". The Examiner recognizes the advantages of the presently claimed

invention by trying to make modifications in Iannuzzi and Hoppe to "to measure errors in "progressive mesh presentation for a graphical geometric model". Rejection of Claim 6 is respectfully traversed. Hoppe has nothing to do with tolerance modeling as claimed. Hoppe uses a procedure to take a mesh (tesselated region) and gradually make it finer. The geometric errors Hoppe is concerned with, are point positions only; these positions are absolute, not relative to a datum system. Also, tolerance analysis must include lines, planes and points as claimed, not just points as disclosed in the references. Further, it is respectfully submitted that a Minkowski sum is not the novel feature of Claim 6. What is claimed as novel is "representing each tolerance zone for each geometric feature of said object comprises a tolerance map representing composite tolerances constructed as a Minkowski sum" (Claim 6).

The Office Action recognizes the advantages of the presently claimed invention by trying to make modifications in Iannuzzi and Hoppe to achieve the claimed invention. It is well settled that in order for a modification or combination of the prior art to be valid, the prior art itself must suggest the modification or combination, "...invention cannot be found obvious unless there was some <u>explicit</u> teaching or suggestion in the art to motivate one of ordinary skill to combine elements so as to create the same invention." *Winner International Royalty Corp. v. Wang*, No. 96-2107, 48 USPQ.2d 1139, 1140 (D.C.D.C. 1998) (emphasis added). "The prior art <u>must provide</u> one of ordinary skill in the art the <u>motivation</u> to make the proposed molecular modifications needed to arrive at the

claimed compound." *In re Jones*, 958 F.2d 347, 21 USPQ.2d 1941, 1944 (Fed. Cir. 1992) (emphasis added). Neither of the references suggests the motivation to modify or combine the references as proposed. The references are individually complete and functionally independent for their limited specific purposes and there would be no reason to make the modification proposed by the Examiner Action. Therefore, because neither of the prior art references suggests the combination and modifications proposed by the Examiner, the combination and modifications are improper.

Further, Applicant respectfully submits that the Examiner is improperly using "hindsight" and the teachings of Applicant's own claimed invention in order to combine references to render Applicants' claims obvious. The Office Action admits that Iannuzzi fails to teach all of the limitations of Applicant's claimed invention. However, the Office Action improperly attempts to modify the Iannuzzi using Hoppe (which also fails to teach all of the limitations of Applicant's claimed invention), in an attempt to achieve Applicant's claimed invention.

Finally, if Applicants' claimed invention were in fact obvious, those skilled in the art would have modified the teachings of Iannuzzi to incorporate the teachings of Hoppe. The fact that neither reference has been modified, to implement Applicants' claimed invention, despite its great advantages, indicates that Applicant's claimed invention is neither obvious nor taught by the prior art. Therefore, for at least the above reasons, rejection Claim 6 should be withdrawn.

Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Iannuzzi in view of Krishnamurthy. The Examiner states that Iannuzzi does not explicitly disclose "variational possibilities of features of said object expressed in Barycentric coordinates" (Claim 9) but that Krishnamurthy discloses such limitation at col. 24, line 29 "barycentric coordinates of the face point" ("face" in Krishnamurthy is a plane). The Office Action recognizes the advantages of the presently claimed invention by trying to make modifications in Iannuzzi and Krishnamurthy to do this in save memory space by using barycentric coordinates. Claim 9 has been amended for clarification. Rejection of Claim 9 is respectfully traversed. Krishnamurthy is not directed to do with GD&T modeling as claimed. Krishnamurthy is directed to creating surfaces on point set data that has already been triangulated. This has nothing to do with the claimed invention. Barycentric coordinates is not being claimed as a novel, rather what is claimed is "representing each tolerance zone for each geometric feature, or cluster of geometric features, of said object comprises creating a tolerance map in a space of points that represent the variational possibilities of manufacture for the features of features of said object expressed in aeral (barycentric) coordinates" (Claim 9).

The Office Action recognizes the advantages of the presently claimed invention by trying to make modifications in Iannuzzi and Krishnamurthy to achieve the claimed invention. It is well settled that in order for a modification or

combination of the prior art to be valid, the prior art itself must suggest the modification or combination, "...invention cannot be found obvious unless there was some explicit teaching or suggestion in the art to motivate one of ordinary skill to combine elements so as to create the same invention." *Winner International Royalty Corp. v. Wang*, No. 96-2107, 48 USPQ.2d 1139, 1140 (D.C.D.C. 1998) (emphasis added). "The prior art must provide one of ordinary skill in the art the motivation to make the proposed molecular modifications needed to arrive at the claimed compound." *In re Jones*, 958 F.2d 347, 21 USPQ.2d 1941, 1944 (Fed. Cir. 1992) (emphasis added). Neither of the references suggests the motivation to modify or combine the references as proposed. The references are individually complete and functionally independent for their limited specific purposes and there would be no reason to make the modification proposed by the Examiner Action. Therefore, because neither of the prior art references suggests the combination and modifications proposed by the Examiner, the combination and modifications are improper.

Further, Applicant respectfully submits that the Examiner is improperly using "hindsight" and the teachings of Applicant's own claimed invention in order to combine references to render Applicants' claims obvious. The Office Action admits that Iannuzzi fails to teach all of the limitations of Applicant's claimed invention. However, the Office Action improperly attempts to modify the Iannuzzi using Krishnamurthy (which also fails to teach all of the limitations of Applicant's claimed invention), in an attempt to achieve Applicant's claimed invention.

Finally, if Applicants' claimed invention were in fact obvious, those skilled in the art would have modified the teachings of Iannuzzi to incorporate the teachings of Krishnamurthy. The fact that neither reference has been modified, to implement Applicants' claimed invention, despite its great advantages, indicates that Applicant's claimed invention is neither obvious nor taught by the prior art. Therefore, for at least the above reasons, rejection Claim 9 should be withdrawn.

Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Iannuzzi in view of Ballas. The Examiner states that Iannuzzi does not disclose "parallelism of variations of said geometric feature" (Claim 10), but that Ballas at col. 25 line 63 discloses "geometric features such as flatness, straightness, circularity, cylindricity perpendicularity, angularity, parallelism, profile of a line or surface, runout (circular), runout (total), concentricity, and wall thickness... circular surfaces ... other geometric shapes such as ellipses, lobed configurations, and even polygons". The Examiner recognizes the advantages of the presently claimed invention by trying to make modifications in Iannuzzi and Ballas in order to model the standard mechanical tolerances. Rejection of Claim 10 is respectfully traversed. Ballas describes a specialty machine for measuring the shape of ax symmetric surfaces, especially the components for taper roller bearings. The construction of the machine and the protocol for operating it are sensitive to datum axes and planes, but this is so that a series of measured

values can be made to correspond to specified limits to variations. Nowhere in Ballas is there any mention of mathematical modeling of GD&T to represent the measurements that might be made with the patented machine, as claimed.

The Office Action recognizes the advantages of the presently claimed invention by trying to make modifications in Iannuzzi and Ballas to achieve the claimed invention. It is well settled that in order for a modification or combination of the prior art to be valid, the prior art itself must suggest the modification or combination, "...invention cannot be found obvious unless there was some <u>explicit</u> teaching or suggestion in the art to motivate one of ordinary skill to combine elements so as to create the same invention." *Winner International Royalty Corp. v. Wang*, No. 96-2107, 48 USPQ.2d 1139, 1140 (D.C.D.C. 1998) (emphasis added). "The prior art <u>must provide</u> one of ordinary skill in the art the <u>motivation</u> to make the proposed molecular modifications needed to arrive at the claimed compound." *In re Jones*, 958 F.2d 347, 21 USPQ.2d 1941, 1944 (Fed. Cir. 1992) (emphasis added). Neither of the references suggests the motivation to modify or combine the references as proposed. The references are individually complete and functionally independent for their limited specific purposes and there would be no reason to make the modification proposed by the Examiner Action. Therefore, because neither of the prior art references suggests the combination and modifications proposed by the Examiner, the combination and modifications are improper.

Further, Applicant respectfully submits that the Examiner is improperly using "hindsight" and the teachings of Applicant's own claimed invention in order to combine references to render Applicants' claims obvious. The Office Action admits that Iannuzzi fails to teach all of the limitations of Applicant's claimed invention. However, the Office Action improperly attempts to modify the Iannuzzi using Ballas (which also fails to teach all of the limitations of Applicant's claimed invention), in an attempt to achieve Applicant's claimed invention.

Finally, if Applicants' claimed invention were in fact obvious, those skilled in the art would have modified the teachings of Iannuzzi to incorporate the teachings of Ballas. The fact that neither reference has been modified, to implement Applicants' claimed invention, despite its great advantages, indicates that Applicant's claimed invention is neither obvious nor taught by the prior art. Therefore, for at least the above reasons, rejection Claim 10 should be withdrawn.

Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Iannuzzi in view of Ballas. The Examiner states that Iannuzzi does not disclose "flatness of said geometric feature" (Claim 11), but that Ballas col. 25, line 63, discloses "geometric features such as flatness, straightness, circularity, cylindricity perpendicularity, angularity, parallelism, profile of a line or surface, runout (circular), runout (total), concentricity, and wall thickness... circular surfaces ... other geometric shapes such as ellipses, lobed configurations, and

even polygons". The Examiner recognizes the advantages of the presently claimed invention by trying to make modifications in Iannuzzi and Ballas in order to model the standard mechanical tolerances. Claim 11 has been amended for clarification. Rejection of Claim 11 is respectfully traversed for similar reasons given above in relation to Claim 10. As such, Claim 11 should be allowed.

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Iannuzzi in view of Carlstrom. The Examiner states that Iannuzzi does not disclose "assembled geometric feature" (Claim 12), but that Carlstrom, col. 1, line 60, disclosed "assemble there from a sequence of segments each having a geometric relationship to other segments". The Examiner recognizes the advantages of the presently claimed invention by trying to make modifications in Iannuzzi and Carlstrom in order to model global tolerance interactions in assemblies of parts with local tolerances. Rejection Claim 12 is respectfully traversed. Carlstrom has nothing to do with GD&T modeling. Rather, Carlstrom simply discloses interpreting computer images as characters, and no relation to the claimed invention.

The Office Action recognizes the advantages of the presently claimed invention by trying to make modifications in Iannuzzi and Carlstrom to achieve the claimed invention. It is well settled that in order for a modification or combination of the prior art to be valid, the prior art itself must suggest the modification or combination, "...invention cannot be found obvious unless there

was some <u>explicit</u> teaching or suggestion in the art to motivate one of ordinary skill to combine elements so as to create the same invention." *Winner International Royalty Corp. v. Wang*, No. 96-2107, 48 USPQ.2d 1139, 1140 (D.C.D.C. 1998) (emphasis added). "The prior art <u>must provide</u> one of ordinary skill in the art the <u>motivation</u> to make the proposed molecular modifications needed to arrive at the claimed compound." *In re Jones*, 958 F.2d 347, 21 USPQ.2d 1941, 1944 (Fed. Cir. 1992) (emphasis added). Neither of the references suggests the motivation to modify or combine the references as proposed. The references are individually complete and functionally independent for their limited specific purposes and there would be no reason to make the modification proposed by the Examiner Action. Therefore, because neither of the prior art references suggests the combination and modifications proposed by the Examiner, the combination and modifications are improper.

Further, Applicant respectfully submits that the Examiner is improperly using "hindsight" and the teachings of Applicant's own claimed invention in order to combine references to render Applicants' claims obvious. The Office Action admits that Iannuzzi fails to teach all of the limitations of Applicant's claimed invention. However, the Office Action improperly attempts to modify the Iannuzzi using Carlstrom (which also fails to teach all of the limitations of Applicant's claimed invention), in an attempt to achieve Applicant's claimed invention.

Finally, if Applicants' claimed invention were in fact obvious, those skilled in the art would have modified the teachings of Iannuzzi to incorporate the teachings of Carlstrom. The fact that neither reference has been modified, to implement Applicants' claimed invention, despite its great advantages, indicates that Applicant's claimed invention is neither obvious nor taught by the prior art. Therefore, for at least the above reasons, rejection Claim 12 should be withdrawn.

Claims 13, 14 and 15 have been canceled.

Claim 18 was rejected under 35 U.S.C. 103 (a) as being unpatentable over Iannuzzi in view of Official Notice (circular pattern). The Examiner states that Iannuzzi does not explicitly disclose "datum reference frames are formed as rigid sets for a circular pattern of bolts" but that takes Official Notice of circular pattern of bolts. The Examiner then states that it would have been obvious to a person of ordinary skill in the art to use Official Notice (circular pattern) to modify Iannuzzi because the flange plane is a convenient datum reference frame as the flange will probably mate to the global datum reference plane or to a second flange plane. Rejection of Claim 18 is respectfully traversed. Though circular pattern of bolts are known, novelty of the claimed invention is not the concept of pattern of bolts. Rather, what is claimed is a method that allows the determination of errors in location/orientation of holes in a pattern. Further, Iannuzzi does not disclose accumulation of tolerances in a stack up condition,

which is the case with patterns. Iannuzzi looks only at entity degrees of freedom, not the total extent (quantitative) or size/shape of individual or accumulated tolerance zones (See discussion above regarding Claim 1). Further, there is no motivation to modify Iannuzzi as suggested by the Patent Office. Therefore, for at least the above reasons, rejection Claim 18 should be withdrawn.

Claim 20 has been canceled and rewritten as new claim 24.

New Claims

The new claims 21-24 are supported by the specification and drawings. For at least the above reasons, the new claims are patentably distinct from the cited references, alone or in combination. As such, the new claims should be allowed.

Further, regarding new claim 24, Maxey (AutoCAD), referenced by the Examiner, only provides overview of Dimensioning functions in Auto CAD R13. Auto CAD is a popular software package for computer-assisted drawing. The dimension lines and tolerance frames created in Auto CAD are just symbols. One can create any type of tolerance frame, valid or invalid, attach it to any type of entity, whether it makes sense or not, and specify any kind of sensible or nonsensical DRF. Auto CAD (and other CAD systems like it) have no instrument to determine if the specified GD&T are valid (or even the drawing represents a physically realizable part). The invention in Claim 24 discloses a model that

provides such an instrument. Modules E1, E2, E3 are commercial software, and modules M1, M2 are standard input modules. Modules M3, M4, M6 and M7 in conjunction with modules E1, E2, E3, M1, M2 and optimal module M5, provide the novel features of the claimed invention.

Conclusion

For the above reasons, and other reasons, it is respectfully submitted that rejection of the claims should be withdrawn. Reexamination, reconsideration and allowance of all claims are respectfully requested.

Respectfully submitted,

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I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington. D.C. 20231, on July 9, 2003
(Date of Deposit)

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Marked-Up Version of the Amended Paragraphs in the Specification

Please replace the paragraph starting on line 17 and ending on line 23 on page 24 of the specification, with the following paragraph:

--One can visualize the possibilities to be the same as those for locating a soda straw of length h and infinitesimal diameter in a cylindrical can, also of length h, which is bounded at its top and bottom by the circles Ç and C, respectively. [Such a set of lines (each of infinite extent) on which the line-segments lie was called a line-solid by Ghosal and Roth in (1987), "Instantaneous Properties of Multi-degrees-of-Freedom Motions-Line Trajectories", ASME J. of Mechanisms, Transmissions, and Automation in Design, 109, 116-124, which is incorporated herein by reference.]--

Please replace the paragraph starting on line 3 and ending on line 20 on page 28 of the specification, with the following paragraph:

--Consider now how the method of the invention treats the tolerance map for cylindrical surfaces. The geometrical character of a cylindrical surface can be represented with a line (axis) and a diameter or radius to specify size. The screw is a mathematical entity perfectly suited to specifying a cylinder. Five independent parameters identify a screw, and every screw lies on a line. One can regard the entire space of screws as all the lines in space for each of which a fifth parameter ranges over the real numbers [(See

Ball, R S. (1998). The Theory Of Screws. Cambridge University Press. [Originally published 1900; now reprinted with a new Forward.]; and Hunt, K. H. (1990). Kinematic geometry of mechanisms. Clarendon Press, Oxford. [Originally published 1978; now reprinted with corrections.])]. In the traditional uses for screws, e.g. in expressing an system of forces as a wrench (a coaxial couple vector and force vector on the line), the fifth parameter is the pitch (p), i.e. the ratio of coaxial couple to force. For our purpose we will use the fifth parameter to express values that range over the tolerance on the size of a cylindrical surface that is centered on a line. We represent the tolerance T on size of a cylindrical surface of length h as a line of length h, which is the axis of the hole (or boss) at true position, together with a circle of diameter T at each end (Fig. 10). The circles define an annular region around the axis that is empty of lines but which represents the tolerance on size.--

<u>Marked-Up Version of the Amended Claims</u>

2. (Amended) The method of claim 1 where representing each tolerance zone for each geometric feature of said object comprises <u>creating</u> a tolerance map <u>in three dimensions</u> representing a plane.

3. (Amended) The method of claim 1 where representing each tolerance zone for each geometric feature of said object <u>further</u> comprises <u>creating</u> a tolerance map <u>in four dimensions</u> representing a <u>line,</u> axis or edge.

4. (Amended) The method of claim 1 where representing each tolerance zone for each geometric feature of said object <u>further</u> comprises <u>creating</u> a tolerance map <u>in five dimensions</u> representing [a] <u>the tolerances for each</u> cylindrical surface<u>, including tolerance on size and the tolerance-zone for the position of the axis of the cylindrical surface</u>.

5. (Amended) The method of claim 1 where representing each tolerance zone for each geometric feature of said object comprises <u>creating</u> a tolerance map representing a position.

8. (Amended) The method of claim 1 where representing each tolerance zone for each geometric feature<u>, or combination of geometric features,</u> of said object comprises <u>creating</u> a tolerance map in a space of points [of] <u>that</u>

represent the variational possibilities of manufacture for the features of said object.

9. (Amended) The method of claim [2] 1 where representing each tolerance zone for each geometric feature, or cluster of geometric features, of said object comprises creating a tolerance map in a space of points [of] that represent the variational possibilities of manufacture for the features of features of said object expressed in [Barycentric] areal (barycentric) coordinates.

11. (Amended) The method of claim 1 where computing in said computer interdependencies between said stored maps and interdependencies between submaps of said stored maps comprises superimposing on a tolerance zone of said geometric feature a tolerance zone specifying form including flatness, straightness and cylindricity of said geometric feature.

Claims 13, 14, 15 and 20 have been canceled.

New claims 21-24 have been added.